The Impact of Tropical Forest Degradation on the Environment

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Abstract

Poverty, over-population, shifiting cultivation, extensive farming and overgrazing, industrialization, uncontrolled logging, seasonal bushfires and the lack of funds and management technology are the main causes of tropical forest degradation. The impacts on the environment include ecological damage like soil degradation, impairment of water retention capacity of forest soils, the loss of bio-diversity, and climatic damage such as regional climatic changes, the increase in atmospheric carbon and global warming. The other indirect impacts deal with socio−economic problems such as the loss of income, and the unbalanced economic development of rual and urban areas. The experience of Sabah, Malaysia in the rehabilitation of the natural forests and wastelands is briefly outlined. There is an urgent need for coordinated planning at the forest sector and management levels, and for developing and applying appropriate forest managemant techniques to these if we ever hope to sustain their productive, protective and recreational functions.

Introduction

The deteriorating global environment has never made its impact more strongly felt today than ever before. People from all areas of the world and from all walks of life are talking about global warming, the thinning of the ozone layer, tropical forest degradation in developing countries, and the threat of pollution to our habitat.

Human activities in the past had virtually wiped out the natural temperate forests and replaced them with plantations. The tropical forest which accounts for more than half of the earth's remaining natural forests is our present concern. Unlike the boreal forests which are sparsely inhabited, the tropical forests are being threatened by population growth and poverty and are desappearing at an estimated rate of 17 million ha, or 0.9%/yr. The area of remaining tropical forests with a minimum of 10% cover of trees/or bamboos is estimated at approximately 1.714 billion ha, (FAO 1991).

In this paper an attempt is made to highlight the main causes and effects of tropical forest degradation. Forest degradation occurs in defferent forms and degrees, and may vary from country to country, region to region, depending on its stage of development and population density. In our discussion, it is proposed that a forest is considered degraded when as a result of outside intervention it is no longer able to sustain any of its economic, protection and recreational functions.

Causes of tropical forest degradation

The causes of forest degradation have been well documented in many countries throughout the ages.

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In Germany, where forest management originated, and like the history of many other developed countries, natural forest degradation occurred due to burgeoning settlements and population, accelerated land clearing for agriculture and grazing, industrialization and wars during the Middle Ages (Klose, 1985).

In the heavily populated Asia-Pacific region, where almost half of the population resides in mountainous areas, degradation is mainly due to population pressure, misuse of land, overgrazing and the lack of environmental safeguards in infrastructural development such as road and dam construction. Shifting cultivation is a major problem. It was estimated that approximately 30 million people depend on subsistence farming covering an area of some 75 million ha, (Rao, 1991).

Indonesia and Thailand singled out expanding population, the demand for economic growth, shifting cultivation, and expanding agricultural land as the mafor causes of deforestation (APO, 1990). In Malaysia, large scale agricultural schemes, exploitation logging and shifting cultivation have been cited as the main causes of forest destruction or degradation.

In the developing countries, poverty is linked with deforestation because it is the poor who rely on farmlands for their needs, on fuelwood to cook their food, and forest products for their livelihood. Most of the people in South and Southeast Asia use fuelwood and charcoal. This consumption contributes to over 80% of the total roundwood removed from the tropical forests and is considered to be the major cause of forest degradation and destruction (Mehl, 1990).

Bushfire, either started by man or by natural factors, is another major cause of tropical forest degradation. Blanket sheets of Imperata grass in abandoned shifting cultivation areas and logging debris make excellent fuel for bushfires. In 1983 the El Nino drought caused bushfires which razed large tracts of grassland and logged forest areas in Borneo Island, destroying an inestimable number of plants and animals. In Sabah even some of the virgin moist torpical forests were not spared from destruction.

The other causes of tropical forest degradation are the lack of funds and management technology. So far the approach to tropical forest management is more on exploitation than multiple-use forestry. Several silvicultural systems have been formulated for tropical forests in the past e.g. Selection Felling, Malayan Uniform system, etc., but so far the track record shows that these silvicultural systems have not achieved the desired results due to problems of enforcement and the lack of commitment to practice sustained yield forestry. *There is a need for concerted action by all concerned, but this would entail more detailed and systematic planning in the forestry sector and the injection of large funds and manpower.*

Impact on the environment

The impact of tropical forest degradation on the environment can be categorized as ecological, climatic and socio-economic.

Ecological impact

Good tropical forest soils rich in nutrients are usually perched on a poor nutrient substrate (Bruijnzeel, 1990) and are sensitive to soil disturbance. Referring to Wiersum's work in soil erosion, Bruijnzeel showed that the removal of the forest cover leads to higher streamflow whilst the reafforestation of open lands decreases it. Soil erosion is minimal in ecosystems where the soil surface is protected by well-developed litter and herb layer and will increase slightly when the understorey is removed (Table 1). However, when the litter layer is destroyed or removed by frequent weeding and burning, the degree of erosion is high.

Soil degradation

It has been shown that road construction and logging are the major causes of surface erosion. Henderson and Witthawatchutikul (1984 cited in Bruijnzeel, 1990) estimated that roads built in a well-vegetated catchment in Thailand washed away approximately 105 tons of soil per hectare, during the first year of road usage. In East Malaysia, Fox (1969) estimated that logging damage by tractor had increased from 14% to 43% between the period 1958 and 1968 since bigger and more poweful logging machines were introduced in Sabah during the early sixties, whilst Liew (1974) estimated that the loss of forest topsoil in steep terrain during the first 6 months following timber extraction ranged between 175 and 266 m^3 per ha.

Table 1 Surface erosion in tropical forest and tree crop systems (ton/ha/yr)

System	Min.	Medium	Max
1 Natural forests	0.03	0.3	6.2
2 Shifting cultivation, fallow period	0.05	0.2	7.4
3 Plantations	0.02	0.6	6.2
4 Tree crops with cover crops	0.10	0.8	5.6
5 Shifting cultivation, cropping	0.4	2.8	70.0
6 Tree crops, clean−weeded	1.2	48.0	183.0
7 Forest plantations, litter removed or burned	5.9	53.0	105.0

Source: Wiersum 1984: Cited in Bruijnzeel, 1990.

Denudation of lowland forests by logging, agricultural development, mining and urbanization contributes to the increase of sediment yield of major watersheds which is estimated at 200 ton km^2/yr (Murtedza and Ti, 1990). This excessive release of suspended solids results in the depletion of nutrients from the forest soil and severe siltation of streams and rivers, which in turn causes power losses, disruption in water supplies and flash floods.

Soil compaction caused by heavy machines and the exposure of forest soil to the elements by forest clearing and logging affects the water retention capacity of forest soils. Malmer and Grip (1990) showed that in the tropical forest in East Malaysia, compacted soils in tractor paths have a very low infiltrability, resulting in the increase of runoff. In the same area Malmer (1992), studying the water yield changes after clear-felling and slash burning, demonstrated that the clearing of the vegetation cover is the main reason for the increase of runoff whilst slash burning substantially contributes to it.

A biomass study by Sim and Nykvist (1991) on a tropical forest intensively logged for pulpwood production showed the poor growth of planted *Acacia mangium* on areas previously logged by tractor, later cleared and burnt, while those grown on areas logged manually and slashed without burning showed a better growth. This phenomenon was attributed to the loss of nutrients by leaching in the burnt areas as indicated by the increase in the content of organic nutrients and conductivity of the stream flow.

A soil study on a shifting cultivation area in steep terrain indicated that cultivation degrades the soil to the extent that it lowers the pH value to below 4.0, decreases the amount of exchangeable base cations like Ca and Mg, and increases the concentration of exchangeable Al in the soil, particularly in the 25 to 40 cm layer. This Al concentration is 88 times higher than that in the soil in the natural forests growing nearby (Martin *et al*, 1992).

Loss of bio-diversity

Due to incomplete data or gaps in knowledge, experts find it difficult to make accurate estimates of the rate of species extinction due to tropical deforestation. The estimates may differ from the theoretical

loss of one species per day increasing to one species every hour, or to a scenario of 50% loss of species by the year 2000 increasing to 100% loss by the year 2010 (Myers 1979; Ehrlich and Ehrlich, 1981, cited in German Bundestag 1990). There is also the danger that the loss of one key species in an ecosystem will lead to the extinction of other species. Most estimates are in reality estimates of species whose populations are being reduced to levels where they will eventually face extinction (Sayer, 1991).

Despite this gap in knowledge it is clear that there is an urgent need to check and reverse the process of tropical deforestation and the destruction of the habitat of species in order to prevent species extinction. For example, in the lowland Dipterocarp forests of Malaysia, several Bornean plants and animals are already considered endangered by non-sustainable logging and poorly planned land development schemes (Murtedza and Ti, 1990). Plant species such as the Rafflesia, mammal species like the Sumatran rhinoceros, orang utan and banteng, and birds such as hornbills and pheasants are threatened by deforestation. Kobayashi (1991) studying the effects fo logging on the torpical forest structure in Brunei showed that the residuals of Dipterocarps experienced 60% damage, and that logging causes the most severe changes in the forest structure. Majuakim (1992) studying the effect of logging on natural rattan estimated that over a period of 4 years after logging only 35% of the rattan survived, compared to a 95% survival in the undisturbed area. In some heavily logged areas in Sabah the aggressive growth of climbing bamboos (*Dinochloa* spp.) and pioneer species like Macaranga poses serious sivicultural problems, and if the causes of their prolific growth are not checked they may lead to an irreversible change of species composition in the area in future.

Climatic impact

According to experts, the burning and/or decomposition of tropical biomass in 1980 has contributed up to 10-30% of the total global CO_2 emissions of 6.6 +/− 1.5 billion metric tons. This massive quantity of CO_2, together with other industrial pollutants, has caused an increase in the concentration of natural trace gases contributing to the greenhouse effect, which affected the exchange of heat radiation in the atmosphere, hence causing global warming. They argued that tropical deforestation is likely to affect the hydrological cycle of the atmosphere and cause a decrease in rainfall. The reduced tree cover influences the amount of water evaporation from the earth's surface and causes an increase in temperature due to the increase of solar radiation reaching the ground. Its effect on the regional climate is associated with reduced rainfall, higher temperature close to ground level, and reduced cloud cover (Greman Bundestag, 1990).

At the present rate of deforestation and degradation of the tropical forests, it is estimated that some 550 billion metric tons of CO_2 will be released into the atmosphere by the end of the century (Baumgartner, 1978 cited in Bruenig, 1991). Although 60% will either be reabsorbed by the oceans or fixed again by trees, the remaining 40% will be absorbed by the atmosphere, hence the increase in the CO_2 concentration. It remains to be determined how far this phenomenon will affect the global climate but its effect on microclimatic changes is certain (Bruenig, 1991). These changes will affect tree growth and the functions of the forests. For example, Kobayashi (1991) observed changes in the microclimate of a logged−over tropical forest in Brunei, caused by the increase in the amount of sunlight reaching the forest floor, fluctuation in the air temperature, and soil damage such as compaction and reduced porosity.

Socio-economic impact

In many tropical countries forest resources play a very important role in revenue generation and economic development. However, there is often a conflict between short-term monetary gains and long−term sustained yield forestry. This is due to the tendency by the forest sector to overcut at the expense of the capacity of the forest to grow. As the timber industry provides employment, revenue and foreign exchange, infrastructure and road access in remote areas, it is essential for these countries to ensure that their forest resources are properly managed and sustained. To do otherwise would result in mass unem-

ployment, the dislocation of the timber industry and the loss of income to the state in future. Unemployment will lead to poverty, and as mentioned earlier poverty will in turn cause increased deforestation.

In timber-rich Sabah, Malaysia, Majugit (1992) reported that despite the rapid development of the forestry sector and the implementation of rural development programs by the government, there is a widening gap in income between the rural and urban areas, and increasing poverty in the rural areas. According to Murtedza and Ti (1991) logging affects the lifestyle of isolated communities in the remote areas because it changes the physical and biological environments as well as the social and economic patterns of the community. It introduces temporary opportunities for wage payment and market outlets for forest products to a stable subsistence economy, changing it to a temporary cash economy. However, once this phase is over the inevitable slump that follows is accompanied by socio-economic problems such as unemployment, forest resource depletion, abandoned access roads, urban migration and heavy dependence on the government for a living.

In an attempt to reduce deforestation by shiftiong cultivation, several rural development schemes were started in many countries. For example, in Sarawak, Malaysia, where one-third of the total land area is affected by shifting cultivation, the Forest Department has adopted various community forest programs which provide people living near the forest estates with the opportunity to participate in reforestation schemes and in agro-forestry projects. The Sabah Forestry Department has also embarked on a similar scheme called the Community Forest Development where housing is provided.

Forest rehabilitation efforts in Malaysia

The rehabilitation of degraded forest land in Sabah, Malaysia started in 1976 when the Sabah Forestry Development Authority (SAFODA) was created to implement the reafforestation of wastelands in shifting cultivation areas. As wasteland occurs in irregular blocks and sizes, the following strategy is adopted: where available *land occurs in small scattered patches* the plantation objective is rehabilitation; *on larger blocks commercial planting* for industrial wood is performed; whilst in *idle private lands* tree farming is promoted. SAFODA expects that these plantations will be able to support a woodchip industry and contribute to the socio-economic development in this poverty-stricken area. Their reafforestation and settlement project in *Bengkoka* aims to estabilish an area of 50,000 ha of *Acacia mangium* plantations with the involvement of 200 settlers from the local subsistence farming community. The settlers are employed as plantation workers and contractors on a semi-permanent basis. At the end of 1991, the agency had planted a total area of 25,799 ha with trees and rattan in Sabah. This figure does not include the industrial plantations of the other agencies amounting to 49,000 ha. The Japan International Cooperation Agency (JICA) is providing assistance to train personnel in reafforestation at the supervisory and forest worker levels.

The Sabah Forestry Department, in collaboration with the German Agency for Technical Cooperation (GTZ), is developing a sustainable forest management system for the logged-over commercial natural forests. *This new approach to sustainable forest management aims to combine the sustainable production of timber and other products following predetermined standards in nutrient cycling, forest structure, bio-diversity, functional diversity and socio-economic factors.* The proposed system has 3 components i.e.; 1) *Planning* at the forest sector, management and operational levels; 2) *Implementation* of resource-compatible, low-impact harvesting methods and diversification of products, and 3) *Control* by yield regulation, EIA, and licensee preformance. The commercial forest estate will be divided into forest management units of approximately 100,000 ha each to facilitate management planning and administration, and further sub-divided into compartments of about 200-600 ha for detailed planning in harvesting, silviculture and implementation. However, this holistic approach is expensive and will require reforms within and without the forestry sector. Its success will depend on the commitment of all concerned, and the injection of large amounts of funds and manpower (Udarbe and Chai, 1992).

Conclusion

Tropical deforestation results in irreversible damage to our ecology and climate, and if it is not checked in time it will lead to serious socio-economic problems and the further extinction of species. We should now act to protect whatever remaining forests we have left before it is too late, and redouble our efforts in reforestation and afforestation. There is a need for coordinated planning in the forest sector and management levels, and a comprehensive forest management system which can strike a balance between economic, ecological and socio-economic requirements.

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